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ABSTRACT

This study was undertaken to develop and field test an instrument designed to measure attitudes of middle school mathematics teachers toward low achievers in mathematics. Three 15-item subscales designed to measure teacher beliefs, feelings, and intended behaviors toward low achievers in mathematics are contained in the Likert-type scale entitled: Teacher Attitudes Toward Low Achievers in Mathematics Scale (TALAM). The study was carried out in three phases. In Phase 1, comments about low achievers in mathematics were elicited from middle school mathematics teachers, experts in the field, and from related literature. In Phase 2, the validated items were administered to 58 middle school mathematics teachers. The data generated were analyzed to estimate validity and reliability. In Phase 3, the final scale was administered to 128 middle school mathematics teachers. The three scales used in Phase 2 were again found to be internally consistent and stable over a 6-week interval. Overall analysis of data yielded substantial support for the TALAM as a valid and reliable measure of attitudes of middle school mathematics teachers toward low achievers in mathematics. (Author/MDH)

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The Development of an Instrument to Measure the Attitudes of Middle School Mathematics Teachers Toward Low Achievers in Mathematics

Evelyn E. Dwyer, Ph.D.

Paper presented at the Annual Meeting of the National Council of Teachers of Mathematics
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National Council of Teachers of Mathematics

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Topic: The Development of an Instrument To Measure The Attitudes of Middle School Mathematics Teachers Toward Low Achievers in Mathematics

ABSTRACT

This study was undertaken to develop and field test an instrument designed to measure attitudes of middle school mathematics teachers toward low achievers in mathematics. Three 15-item subscales designed to measure teacher beliefs, feelings, and intended behaviors toward low achievers in mathematics are contained in this 45-item Likert-type scale titled: Teacher Attitudes Toward Low Achievers in Mathematics Scale (TALAM).

The study was carried out in three phases. In Phase 1, comments about low achievers in mathematics were elicited from middle school mathematics teachers, experts in the field of mathematics and mathematics education, and from related literature. Statements were further validated by a panel of experts.

In Phase 2, the validated items were administered to 58 middle school mathematics teachers. The data generated were analyzed to estimate validity and reliability. Items were retained for the final scale if they had significant ($p < .01$) item-total correlations and the ability to discriminate between

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high and low criterion groups ($p < .05$). The three scales were found to be internally consistent (Cronbach's alpha range: .80 - .91). Principal component factor analysis of data resulted in three empirically distinguishable factors consistent with placement of statements within the three subscales and indicative of construct validity.

In Phase 3, the final scale was administered to 128 middle school mathematics teachers. The three scales were again found to be internally consistent (Cronbach's alpha range: .70 -.91) and stable (r coefficient range: .70 - .82) over a six-week interval. Concurrent and differential validity were also determined. The attudinal components measured by the TALAM scales differed from those measured by the Revised Math Attitude Scale suggesting that teachers' attitudes toward mathematics in general are distinct from attitudes toward low achievers in mathematics. Further, the relationship between the TALAM scale and a previously developed semantic differential scale purporting to measure teacher attitudes toward low achievers in general was determined. Data analysis produced significant Pearson product-moment correlations ($p < .01$) between TALAM scales and the semantic differential scale (r coefficient range: .38 - .50).

Overall analysis of data yielded substantial support for the TALAM as a valid and reliable measure of attitudes of middle school mathematics teachers toward low achievers in mathematics. This contention, along with review of earlier research, provides support for further study of the relationship between teacher attitudes toward low achievers in mathematics and a variety of other variables.

INTRODUCTION

This study involved the development of an instrument to measure teacher attitudes toward low achievers in mathematics.

Abundant research indicates that teacher attitudes and behaviors have a great deal of influence on student achievement, not just in mathematics, but across the curriculum. Many researchers believe that teachers are viewed as the prime determiners of both student attitude and performance in mathematics. The literature contains abundant empirical evidence documenting what appears to be inappropriate and differential treatment by teachers toward students perceived by them as low achievers.

It is not surprising then, that the National Council of Teachers of Mathematics recommends that mathematics teachers must develp and maintain positive attitudes and high expectations for all students including those who are or who are perceived to be low achievers in mathematics. Specifically, low achievers in mathematics deserve and require the same degree of supportiveness, respect, response opportunities, and encouragement from their teachers that high achievers received. Mathematics teachers are advised by NCTM to treat all students as though they are expected to meet at least minimum specified achievement goals. With this in mind, a study was undertaken to develop and field test an instrument designed to measure attitudes of mathematics teachers toward low achievers in mathematics. This particular study was focused on teachers of mathematics in the middle grades six through eight.

PHASE I READINESS (See Trans. #1 in Appendix).

This phase consisted of

1. Selection of instrument type and format
2. Writing of potential items
3. Classification of item directionality by panel of experts/judges
4. Preparation of preliminary attitude scale

1. Selection of instrument type and format

The strengths and weaknesses of each of four scaling techniques were considered. (See Trans. #2 in Appendix). The strengths of the Likert technique appeared to far outweigh the strengths of other scales under consideration. The weaknesses of the Likert appeared to be minimal in comparison with other type scales.

Some of the strengths of the Likert appeared to be as follows: (See Trans. #3 in Appendix).

(a) Easy to administer and score,

(b) Used more often than other scaling techniques,

(c) Capable of being utilized by a wide variety of individuals in a variety of settings,

(d) Adaptable to modification in response alternatives and statement format.

The Likert technique appeared to have potential for exhibiting the important qualities of an attitude scale emphasized by Anderson (1981): communication value, objectivity, validity, reliability, and interpretability.

2. Writing of potential items

A survey of research containing recommendations and criteria for writing Likert items was conducted. A review of literature concerning the complex, inter-related components of attitude was also undertaken. Subsequently, in keeping with major research recommendations, the decision was made to generate attitudinal Likert items belonging in three major categories: beliefs, feelings, and intended behaviors with regard to low achievers in mathematics. (See Trans. #4 in Appendix).

One hundred twenty-eight items were written based on:

(a) input from middle school mathematics teachers,

(b) consultation with professionals in mathematics and mathematics education at the college level and,

(c) research literature and other scales

The items were placed in three major categories: beliefs, feelings, and intended behaviors with regard to low achievers in mathematics. Further, half of the items were worded positively and half negatively with regard to low achievers in mathematics.

3. Classification of Items by Judges

In order to begin establishing the positive or negative directionality of Likert items and also to establish the placement of Likert items into the appropriate subscale, all one hundred twenty-eight items were studied by ten experts in the fields of mathematics, mathematics education, and psychology. Judges were asked to sort items into three categories: beliefs, feelings, and intended behaviors. They were also asked to rate

each individual item as being positive, negative, or undecided i.e. neutral with regard to low achievers in mathematics.

4. Preparation of Preliminary Attitude Scale

An item was considered to be clear in directionality if nine out of 10 experts rated it as being clearly positive or negative with regard to low achievers in mathematics. Items were retained in the three subscales only if subscale placement was agreed upon by nine out of ten of the experts.

After careful consideration by the judges and the researcher, 85 out of the 128 items (66%) were retained for use in the preliminary Likert scales in the pilot study.

PHASE II THE PILOT STUDY (See Trans. #5 in Appendix).

The purpose of Phase II was to evaluate the potential of all 85 Likert items for possible inclusion in the final attitude scale or scales. Through analysis of preliminary scale data, estimations of the internal-consistency of each item and the discriminating quality of each item was evaluated. Further, through analysis of preliminary scale data, a decision could be made relative to the need for one attitude scale with a summative score or three subscales.

The sample for the pilot study consisted of all the middle school mathematics teachers (n = 55) from the Tri-cities region in Johnson City, Tennessee. Directions and administration took approximately 25 minutes.

Data analysis consisted of the following procedures:

1. Scoring of Preliminary Scale and Subscales

The responses to all items were summed after responses to all negative items had been reversed. Scores were tabluated for each individual for each subscale and the total scale. Score distributions were examined and quartiles established for each subscale and for the total scale.

2. Comparison of Scale Means

Student t-tests were conducted comparing mean scores for each of the three subscales and for the total scale.

Example: Beliefs - Feelings
Beliefs - Intended Behaviors
Beliefs - Total Scale

Significant differences among means were found ($p < .001$) between each pair or subscales and between each subscale and the total scale. This result was indicative of a need for three distinct subscale scores as opposed to just one summated total score.

3. Item Analysis

Item analysis was conducted for each of the three subscales and for the total scale. All items in each scale were examined to determine the discriminating ability of each item. That is, when a positively written item is valid, subjects with a generally positive attitude will respond "agree" or "strongly agree" to the Likert item while those with a generally negative attitude would respond "disagree" or "strongly disagree" to the item. (See Trans. #6 in Appendix).

A positive and a negative criterion group was determined for each subscale and for the total scale. That is, in each scale, 25% of subjects with the highest summated score were considered the positive criterion group and 25% of subjects with the lowest summated score were considered the negative criterion group. The mean score for each individual item was computed for both the high and low criterion groups and compared through the use of the student t-statistic. Significant differences ($p<.01$) between high and low criterion group mean scores was indicative of the items ability to discriminate adequately between positive and negative criterion groups. Seven items were discarded due to insufficient discriminating quality between high and low criterion groups.

4. Item to Scale Correlations and Internal Consistency Estimates of Reliability (Cronbach's Alpha)

Item to scale correlations for each item within each subscale and within the total scale were also conducted. (See Trans. #7 in Appendix). Significant correlations between individual item scores and total scale scores suggested that the item represented the attitude under study. Items were eliminated from each subscale if correlations were not statistically significant ($p<.001$). Thirty-three items were discarded due to low item to scale correlations. All items retained had significant ($p<.001$) item to scale correlatons > or = to .87.

An overall internal-consistency reliability measure was conducted (Cronbach's Alpha). Reliability coefficients ranged from .88 to .91 for each of the subscales and for the total scale.

5. Construction of the Final Attitude Scales

Based on information obtained through the use of the statistical procedures described in Phase II, a 45 item final attitude scale containing three subscales of 15 items each was constructed. Consideration was given to equal representation of items from each of the belief, feeling, and intended behavior categories. Further, a nearly equal mix of positively worded and negatively worded items was selected to comprise each of the subscales.

After the 15 items were selected for each subscale, data were again analyzed taking into consideration only those items to be used in the final instrument. Item to scale correlations ranged from .78 to .91 on the subscales and total 45 item scale. All were statistically significant correlations at $p<.001$. Internal consistency estimates of reliability (coefficient alpha) for the subscales and the total scale ranged from .88 to .91. (See Trans. #8 in Appendix).

PHASE III ADMINISTRATON OF THE FINAL SCALE (See Trans. #9 in Appendix).

Phase III involved administration of the final form of the attitude scale entitled, Teachers Attitude Toward Low Achievers in Mathematics (TALAM) to 128 middle school mathematics teachers with a 6 week period test/retest interval. Further, the Revised Math Attitude Scale (RMAS) by Aiken and Dreger (1963) and a semantic differential scale measuring teacher attitude toward low achievers by Steeg (1983) was administered to the same subjects. Scores were obtained for all subjects and data were subsequently analyzed. A summary of data analysis follows:

1. Tests of Significance and Multiple Comparisons

A one-way analysis of variance was used to test the significance of the differences among the means of TALAM subscales and total scale. A significant difference among means was determine ($p<.01$) indicating greater variation among means than would be expected by chance. Scheffe's multiple comparison method was used to compare all possible pairs of means. Differences between several pairs of means were identified at the $p<.05$ level of significance.

2. Correlations

The TALAM was administered twice to the sample of 128 subjects. Scores were compared using the Pearson product-moment correlation. Test-Retest correlations were all statistically significant at the .001 level and ranged fromm .70 to .82.

Pearson product-moment correlations were also used to compare TALAM subscale and total scale scores with scores obtained from administrations of the Aiken and Dreger's Revised Mathematics Attitude Scale and Steeg's semantic differential scale. There was no significant correlation between any of the TALAM subscale scores or the total TALAM scores with Aiken and Dreger's Revised Mathematics Attitude Scale. However, there were significant correlations between the belief scale and Steeg's semantic differential scale, between the feeling scale and Steeg's semantic differential scale, and between the total TALAM scale and Steeg's semantic differential scale at the $p<.01$ level of significance. There was no significant correlation between

the intended behavior scale and Steeg's semantic differential scale. This result was not surprizing given that Steeg's semantic differential scale did not purport to measure this aspect of attitude toward low achievers in mathematics. (See Trans. #10 in Appendix).

CONCLUSIONS:

The Teacher Attitudes Toward Low Achievers in Mathematics Scale (TALAM) was demonstrated to be a valid and reliable indicator of teacher beliefs, feelings, and intended behaviors with regard to low achievers in mathematics. Therefore, the TALAM appears to be a viable method for assessing teacher attitude toward such students.

Teacher attitude toward low achievers in mathematics appears to be multidimensional in nature. That is, teacher beliefs, feelings, and intended behaviors are highly related components of attitude but are also separate constructs that may or may not be consistent within individuals and among groups.

Recommendations for Use of the TALAM Scale

The TALAM subscale and total scale scores might be used as a basis for designing attitude profiles for individuals or groups. A profile sheet would contain a simple two-dimensional graph with the vertical axis labelled with the range of scores, over all scales, and the horizontal axis labelled with the attitude components measured by each of the subscales and total scale.

Administration of the TALAM scale could be used as the basis for integrating and stressing affective goals for students,

teachers, and administrators as an integral part of the curriculum of the school. The attitudes of faculty toward low achievers in mathematics as measured by the TALAM can be important consideratons in the adoption and implementation of school in-service or other instructional programs.

Transparency #1

PHASE I READINESS

This phase consisted of

1. Selection of instrument type and format
2. Writing of potential items
3. Classification of item directionality by panel of experts/judges
4. Preparation of preliminary attitude scale

Transparency #2

PHASE II THE PILOT STUDY

n = 58

1. **Administration of 85 item preliminary scale**

2. **Scoring of scale**

3. **Data Analysis**

   a. **Student t-test procedure**

   b. **Item-to-Scale correlations**

   c. **Internal-consistency estimates of reliability (Cronbach's Alpha)**

Transparency #3

PHASE III

ADMINISTRATION OF FINAL ATTITUDE SCALE

n = 128

1. Instrumentation
   a. Teacher Attitude Toward Low Achievers in Mathematics Scale (TALAM)
   b. Revised Math Attitude Scale (RMAS) (Aiken and Dreger, 1963)
   c. Semantic differential scale (Steeg)
2. Administration of instruments
3. Retest of TALAM
4. Scoring of Instruments
5. Data Analysis
   a. Descriptive statistics
   b. Analysis of variance (ANOVA)
   c. Scheffe's Multiple Comparison
   d. Pearson product-moment correlations
   e. Internal-consistency estimates of reliability (Cronbach's alpha)

Transparency #4

SCALING TECHNIQUES CONSIDERED

1. Thurstone Techniques

2. Likert Scale

3. Guttman Scale

4. Semantic Differential Scale

Transparency #5

STRENGTHS OF LIKERT TECHNIQUE

1. Easy to administer and score
2. Used more often than other techniques
3. Capable of being utilized by a wide variety of individuals in a variety of settings
4. Adaptable to modification in response alternatives and statement format

TECHNIQUE HAD POTENTIAL FOR

1. Communication value
2. Objectivity
3. Validity
4. Reliability
5. Interpretability

Transparency #6

ATTITUDES TOWARD LOW ACHIEVERS

IN MATHEMATICS

1. **Teacher BELIEFS about low achievers**

2. **Teacher FEELINGS about low achievers**

3. **Intended BEHAVIORS with regard to low achievers**

Transparency #7

Sample of Student's t Analysis for One Item.

Calculated t = - 4.21*

Scale: Teacher Belief			Item No. 4(+)					
			Frequency of Responses					
Group	X	s	1	2	3	4	5	6
Low	3.08	1.24	1	4	5	1	1	1
High	4.58	1.00	0	0	2	3	5	2

Degrees of Freedom: 22

* 2-tailed significance level: $p < .05$

Critical value of t: (+/-) 2.07

Transparency #8

Internal-Consistency Estimates

of Reliability (Coefficient Alpha)

Preliminary Scales

Scale	No. of items	Coefficient Alpha
BELIEFS	34	.89**
FEELINGS (TEACHER)	25	.88**
INTENDED BEHAVIORS	26	.78**
TOTAL	85	.93**

n = 58 ** 1-tailed significance level: p < .01

Transparency #9

Internal-Consistency Estimates

of Reliability (Coefficient Alpha)

Revised Scales

Scale	No. of items	Coefficient Alpha
BELIEFS	15	.88
FEELINGS (TEACHER)	15	.90
INTENDED BEHAVIORS	15	.80
TOTAL	45	.91

n = 58

Transparency #10

Internal-Consistency Estimates
of Reliability (Cronbach's Alpha)
for the Final Scales

Scale	# Items	Coefficient Alpha
Beliefs	15	.84**
Feelings	15	.86**
Int. Behaviors	15	.70**
Total Scale	45	.90**

n = 128 ** 1-tailed level of significance: $p < .01$